

Simulation of Relativistic Shocks and Associated Self-consistent Radiation for GRB Prompt Emission and Afterglows

Ken-Ichi Nishikawa¹, J. Niemiec, ², M. Medvedev, ³,
B. Zhang, ⁴, P. Hardee, ⁵, Y. Mizuno, ¹, A. Nordlund, ⁶,
J. Frederiksen, ⁶, H. Sol, ⁷, M. Pohl, ⁸, D. H. Hartmann, ⁹,
S. Guiriec, ¹, G. J. Fishman, ¹⁰,

1NSSTC,
2Institute of Nuclear Physics PAN, Poland,
3University of Kansas,
4University of Nevada, Las Vegas,
5The University of Alabama, Tuscaloosa,
6University of Copenhagen, Denmark,
7Observatoire de Paris-Meudon, France,
8University of Potsdam, Germany,
9Clemson University,
10NASA/MSFC

Plasma instabilities excited in collisionless shocks are responsible for particle acceleration. We have investigated the particle acceleration and shock structure associated with an unmagnetized relativistic electron-positron jet propagating into an unmagnetized electron-positron plasma. Cold jet electrons are thermalized and slowed while the ambient electrons are swept up to create a partially developed hydrodynamic-like shock structure. In the leading shock, electron density increases by a factor of about 3.5 in the simulation frame. Strong electromagnetic fields are generated in the trailing shock and provide an emission site. This simulation corresponds to a case for gamma-ray burst afterglows. We will simulate colliding shells as an internal shock model for prompt emission. Turbulent magnetic fields generated by a slower shell will be collided by a faster shell. These magnetic fields contribute to the electron's transverse deflection behind the shock. We calculate the radiation from deflected electrons in the turbulent magnetic fields. The properties of this radiation may be important to understanding the complex time evolution and/or spectral structure in gamma-ray bursts.